

Midwest RPO Modeling

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12/3/2002





Objectives

- Compare photochemical model estimates to observed estimates
- Compare relative differences in estimates by each of the photochemical models
- Determine relative costs for running each model in terms of file storage size, execution speed, and staff time required for implementation

EPISODES

- August 2 - Sept 12, 1999
 - 8-hr ozone episode: Sept 1-5
 - March Midwest daily PM speciation data at 5 sites
 - Atlanta Super Site intensive modeling
- Jan 2 - Feb 17, 2000
 - 8-hr ozone episode: None
 - March Midwest daily PM speciation data at 3 sites
- June 18 - Aug 13, 2001
 - 8-hr ozone episodes: June 25-30, July 15-24, Aug 5-9
 - PM Super-Site intensive modeling @ St. Louis and Pittsburgh

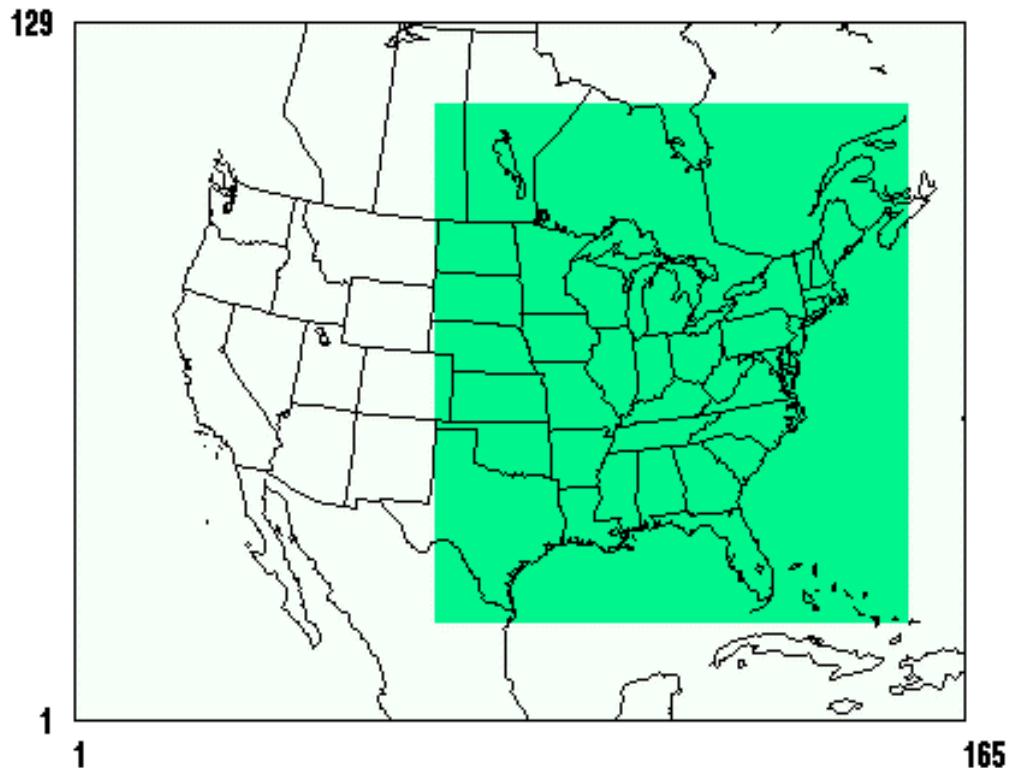
MODELS

- CMAQ
 - June 2002 release
- CAMx
 - version 3.10
 - mechanism 4 (beta)
- REMSAD
 - version 7.03
- Near-Future
 - PMCAMx (beta)

Lambert projection: (-97,40) 33,45

MM5 36km grid: 165 X 129 Y 35 Z

PCM 36km grid: 87 X 95 Y 16 Z

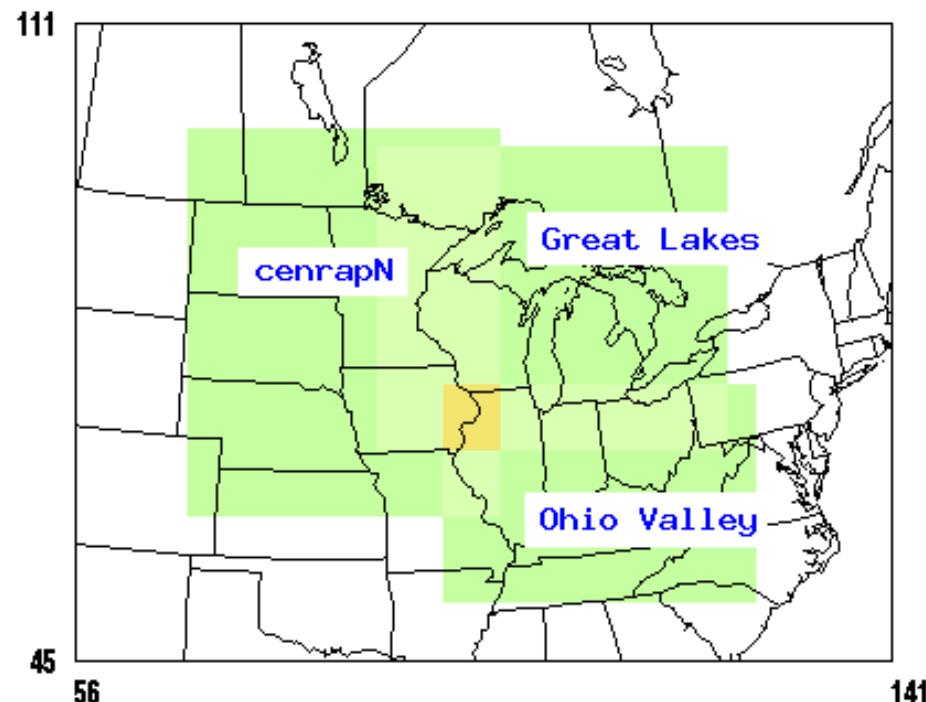


Computing Platform:
RedHat Linux 7.X, PGI fortran

k(MM5)	sigma	height(m)	k(PCM)
35	0.000	15674	16
34	0.050	13670	
33	0.100	12085	
32	0.150	10764	
31	0.200	9625	15
30	0.250	8621	
29	0.300	7720	
28	0.350	6903	
27	0.400	6153	14
26	0.440	5595	
25	0.480	5068	
24	0.520	4570	
23	0.560	4096	13
22	0.600	3644	
21	0.640	3213	
20	0.670	2902	12
19	0.700	2600	
18	0.730	2308	11
17	0.760	2023	
16	0.785	1793	10
15	0.810	1567	
14	0.835	1346	9
13	0.855	1173	
12	0.875	1003	8
11	0.895	836	
10	0.910	712	7
9	0.925	590	
8	0.940	469	6
7	0.950	389	
6	0.960	310	5
5	0.970	232	
4	0.980	154	4
3	0.986	108	3
2	0.992	61	2
1	0.996	31	1
0	1.000	0	--SURF--

MM5: Pleim-Xu LSM, RRTM, Simple Ice, Kain-Fritsch

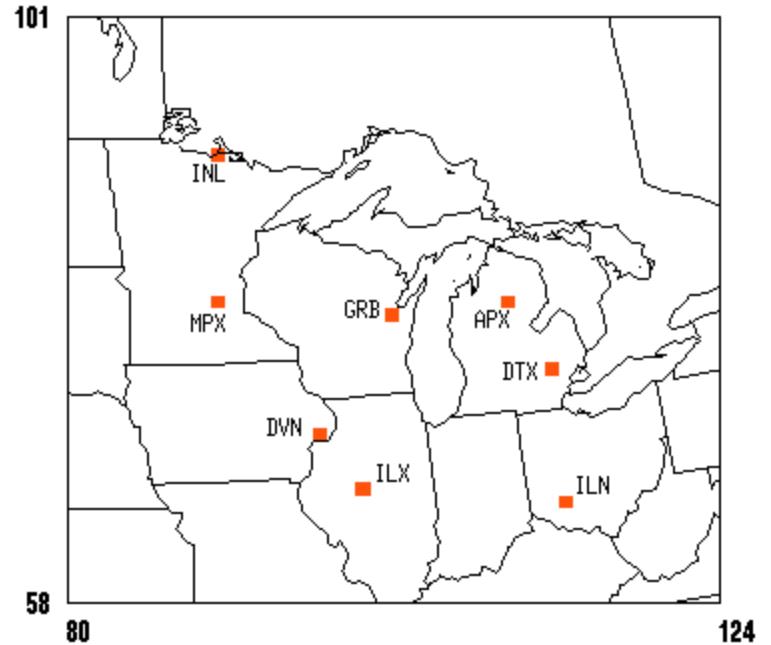
MM5 Model Performance Regions



*Approximate Number of Stations:

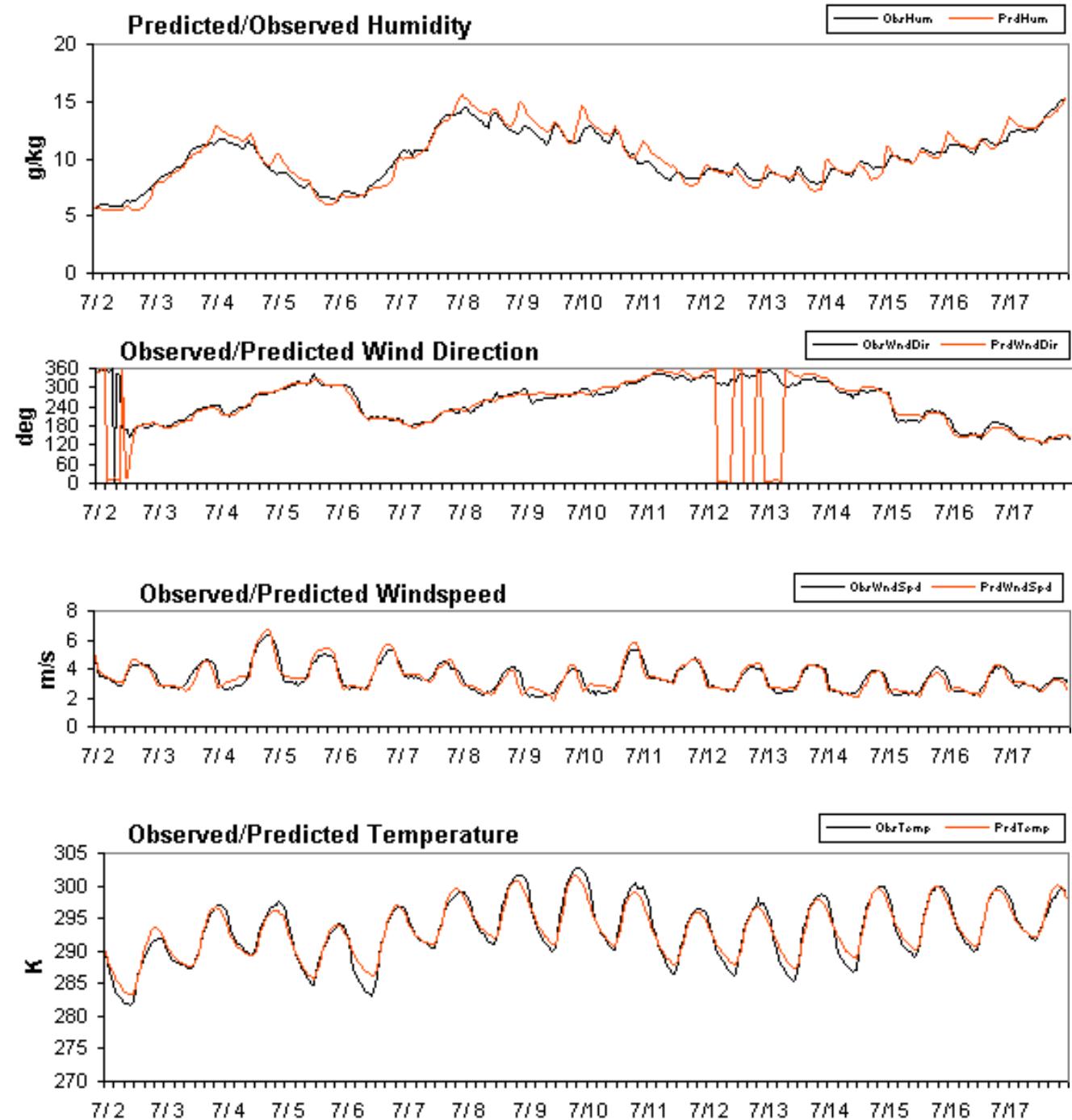
Great Lakes (280) Ohio Valley (190) cenrapN (270)

Upper Air Meteorological Monitors

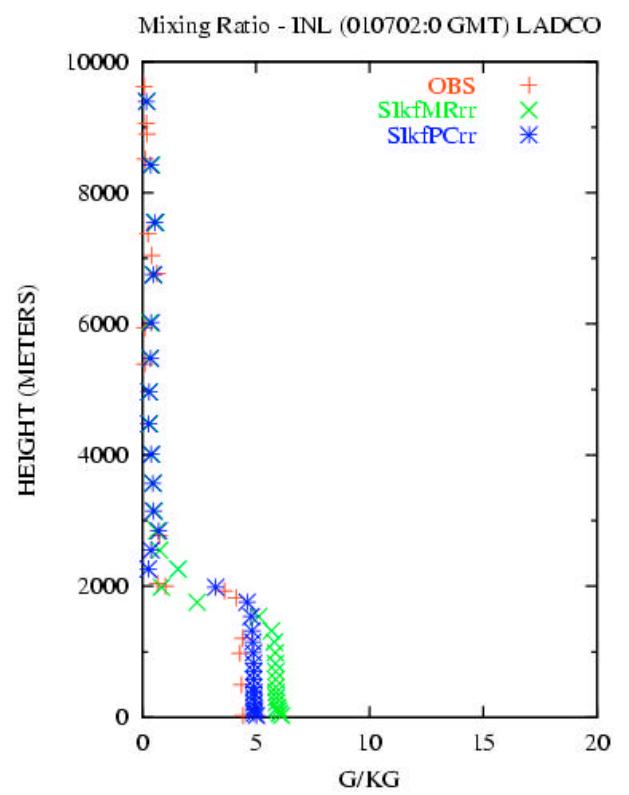
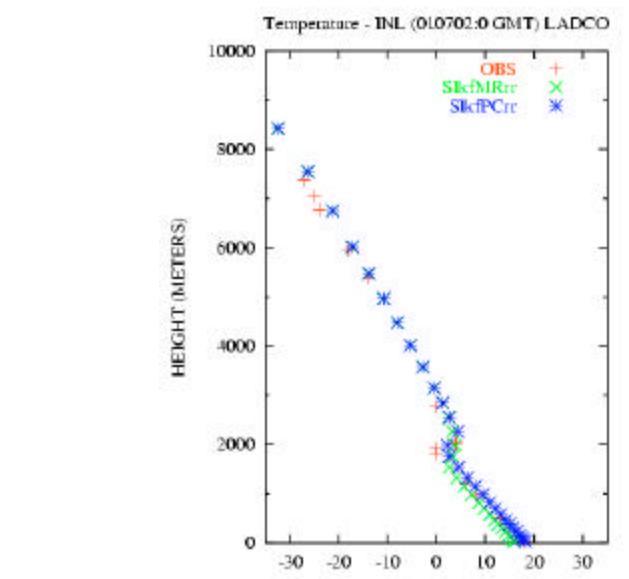
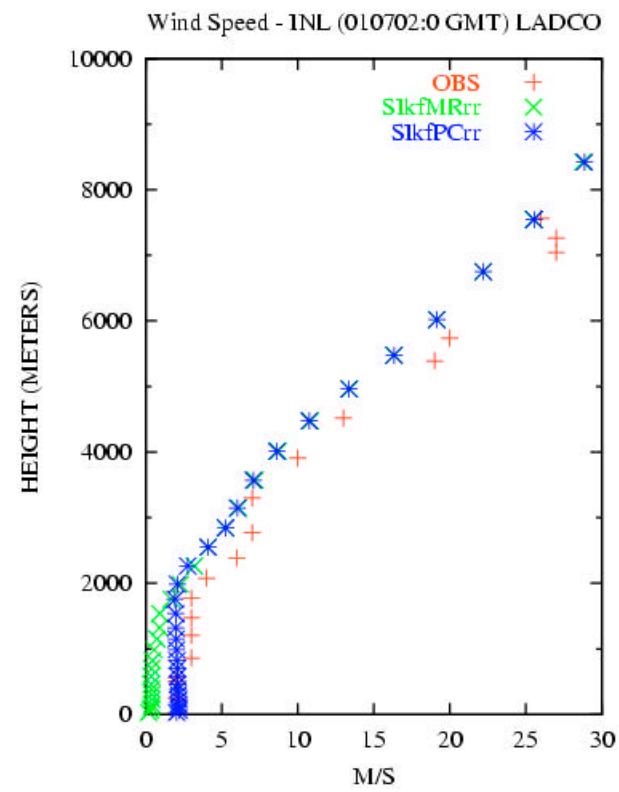
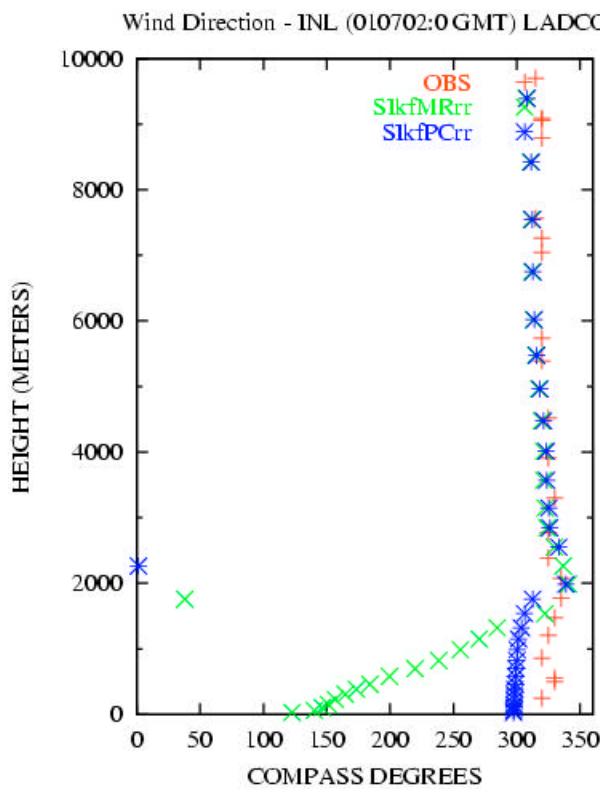


Great Lakes Area -
(simple ice, kain-
fritsh, PX, rrtm)

- Improved humidity prediction with Pleim-Xu
- Improved maximum temperature prediction with Pleim-Xu
- Vastly improved wind field prediction with Pleim-Xu
- Should result in more accurate pollution transport



Pleim-Xu LSM (blue) vs MRF/5 Layer Soil Model (green) Observations (red)



EMS 2001 Emissions Modeling

- Point source inventory based on NEI 1999
- Biogenics based on BIOME3/BEIS3 with BELD3 landuse and MM5 15 m temperatures and MM5 PAR
- Area, on-road mobile, non-road mobile based on 1999 NEI

Speciation for Models

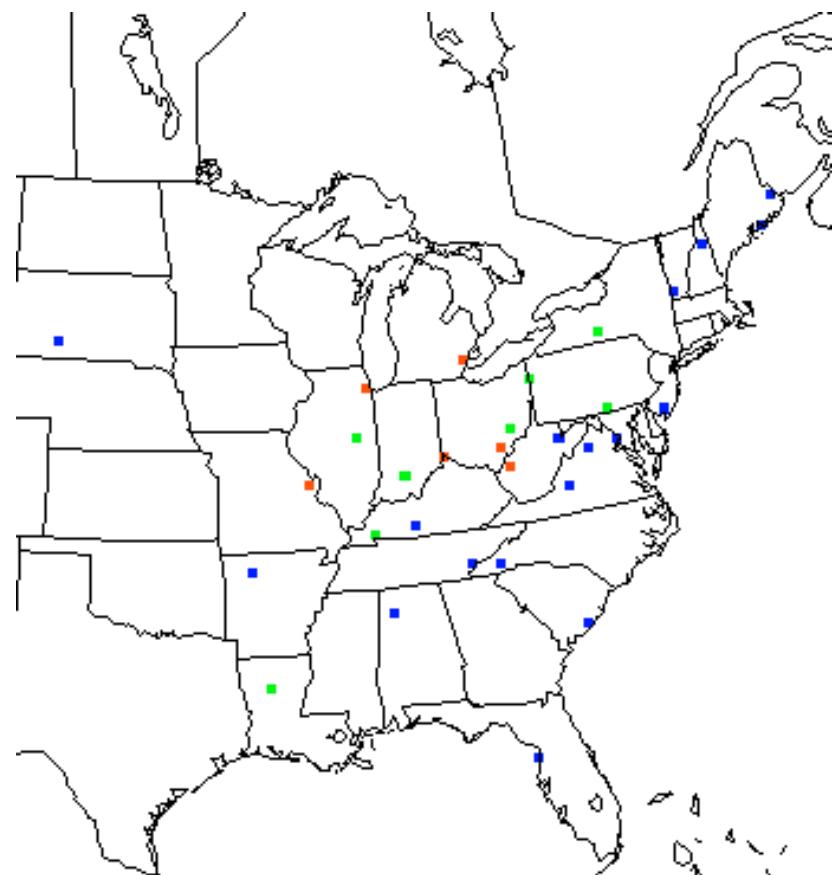
Full CB4 = CMAQ, CAMx-M4, PMCAMx

Micro-CB4 = REMSADv7

CMAQ	REMSADv7	PMCAMx	CAMx-M4	DESCRIPTION
ALD2	(VOC) CARB = VOC * 0.03	ALD2	ALD2	Aldehydes Carbonyls
ETH	(VOC)	ETH	ETH	Ethylene
FORM	(VOC)	FORM	FORM	Formaldehyde
ISOP	ISOP = ISOP + (10/5)*(OVOC)/3	ISOP	ISOP	Isoprene
TERPB	TERP	TERP	.	Monoterpenes
.	(VOC)	OLE	OLE	Olefins - Anthropogenic
.	.	OLE2	OLE2	Olefins - Biogenic (OVOC)
OLE	.			Olefins (anthropogenic & biogenic)
PAR	(VOC)	PAR	PAR	Paraffins
TOL	TOL	TOL	TOL	Toluene
.	VOC = 2*ALD2 + 2*ETH + FORM + 2*OLE + 7*TOL + 8*XYL + PAR	.	.	VOC - Anthropogenic
XYL	XYL	XYL	XYL	Xylene
NH3	NH3	NH3	NH3	Ammonia
CO	CO	CO	CO	Carbon monoxide
NO2	NO2	NO2	NO2	Nitrogen dioxide
NO	NO	NO	NO	Nitrogen oxide
SULF	SULF	SULF	SULF	Sulfur
SO2	SO2	SO2	SO2	Sulfur dioxide
PMC	PMCOARS	PCRS[1-10]	PCRS	Primary PM-coarse
PMFINE	PMFINE	PFIN[1-10]	PFIN	Primary PM-fine "other"
PEC	PEC	EC[1-10]	EC	Primary PM-fine elemental carbon
PNO3	PNO3	PNO3[1-10]	PNO3	Primary PM-fine nitrate
POA	POA	OC[1-10]	OC	Primary PM-fine organic aerosol
PSO4	GSO4	PSO4[1-10]	PSO4	Primary PM-fine sulfate

Model Performance

- **March Midwest (red)**
 - daily 24 hr samples
 - Only 3 of 6 stations in winter 2000
 - PM2.5 Speciation
 - NH₃, HNO₃, HNO₂, SO₂
- **IMPROVE (blue)**
 - 24 hr samples every 3 days
 - PM2.5 Speciation
- **CASTnet Visibility (green)**
 - 24 hr samples every 3 days
 - PM2.5 Speciation
- **AIRS**
 - Hourly criteria pollutants
 - SO₂, NO_X, O₃, CO



Monitor to Model Definitions of Pollutants

NETWORK	Recon PM2.5	PM2.5	Sulfate	Nitrate	EC	OC	Crustal/Soil	Ammonium	Coarse Mass	PM10
IMPROVE (raw data)	$1.37*\text{SO}_4 + 1.29*\text{NO}_3 + (\text{EC1} + \text{EC2} + \text{EC3-OP}) + [1.4*(\text{OC1} + \text{OC2} + \text{OC3+O}\text{C4+OP})] + (2.20*\text{Al} + 2.49*\text{Si} + 1.63*\text{Ca} + 2.42*\text{Fe} + 1.94*\text{Ti})$	MF	$\text{SO}_4 \text{ or } 3*\text{S}$	NO_3	$\text{EC1} + \text{EC2} + \text{EC3 - OP}$	$1.4*(\text{OC1} + \text{OC2} + \text{OC3} + \text{OC4} + \text{OP})$	$2.20*\text{Al} + 2.49*\text{Si} + 1.63*\text{Ca} + 2.42*\text{Fe} + 1.94*\text{Ti}$	$.37*\text{SO}_4 + .29*\text{NO}_3$	MT - MF	MT
CASTNET Visibility	$1.37*\text{SO}_4 + 1.29*\text{NO}_3 + 1.4*\text{OCTC} + \text{ECTC} + \text{SOIL}$	FINE_MASS	SO_4	NO_3	ECTC	$1.4*\text{OCTC}$	$2.20*\text{Al} + 2.49*\text{Si} + 1.63*\text{Ca} + 2.42*\text{Fe} + 1.94*\text{Ti}$	$.37*\text{SO}_4 + .29*\text{NO}_3$		
March Midwst	$\text{SO}_4 + \text{NO}_3 + \text{EC} + 1.4*\text{OC} + \text{SOIL} + \text{AMMON}$	PMF	SO_4	NO_3	EC	$1.4*\text{OC}$	SOIL	AMMON		
AIRS		PM2.5							PM10-PM2.5	PM10
MODEL	Recon PM2.5	PM2.5	Sulfate	Nitrate	EC	OC	Crustal/Soil	Ammonium	Coarse Mass	PM10
REMSAD	$\text{ASO}_4 + \text{GSO}_4 + \text{PNO}_3 + \text{SOA} + \text{PEC} + \text{POA} + \text{PMFINE} + \text{NH4N} + \text{NH4S}$	<<--SAME	$\text{ASO}_4 + \text{GSO}_4$	PNO_3	PEC	$\text{SOA} + \text{POA}$	PMFINE	$\text{NH4N} + \text{NH4S}$	PMCOARS	[Recon PM2.5] + PMCOARS
CAMx-M4	$\text{PSO}_4 + \text{PNO}_3 + \text{EC} + \text{OC} + \text{PFIN} + \text{PNH4}$	<<--SAME	PSO_4	PNO_3	EC	OC	PFIN	PNH4	PCRS	$\text{PSO}_4 + \text{PNO}_3 + \text{EC} + \text{OC} + \text{PFIN} + \text{PNH4} + \text{PCRS}$
CMAQ	$\text{ASO4I} + \text{ASO4J} + \text{ANO3I} + \text{ANO3J} + \text{ANH4I} + \text{ANH4J} + \text{AORGAI} + \text{AORG AJ} + \text{AORGPAI} + \text{AORGPAJ} + \text{AORGBI} + \text{AORGBJ} + \text{AEI} + \text{AECJ} + \text{A25I} + \text{A25J}$	<<--SAME	$\text{ASO4I} + \text{ASO4J}$	$\text{ANO3I} + \text{ANO3J}$	$\text{AEI} + \text{AECJ}$	$\text{AORGAI} + \text{AORG AJ} + \text{AORGPAI} + \text{AORGPAJ} + \text{AORGBI} + \text{AORGBJ}$	$\text{A25I} + \text{A25J}$	$\text{ANH4I} + \text{ANH4J}$	ASEAS + ASOIL + ACORS	[Recon PM2.5] + [Coarse Mass]

Model Runs

CMAQ

Case	Episode
baseA	Jan 00, Aug 99
beis3nonox	Jan 00, Aug 99
cem	Aug 99
cmu	Jan 00, Aug 99
combo1	Aug 99
dust	Jan 00, Aug 99
s1nonroad	Jan 00, Aug 99

CAMx-M4(beta)

Case	Episode
baseAcamx	Aug 99
combo1camx	Aug 99

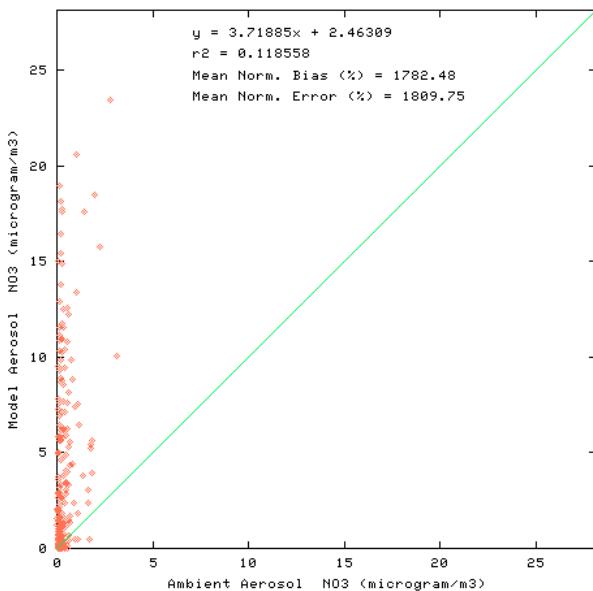
REMSAD

Case	Episode
baseAremsad	Aug 99
combo1remsad	Aug 99

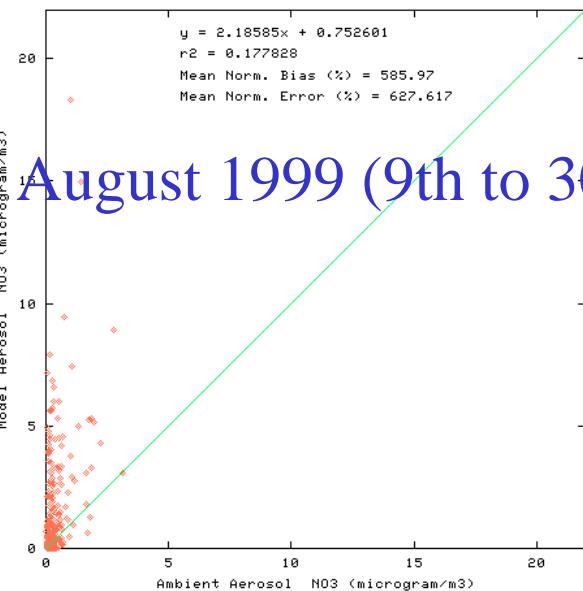
Run

Run	Description
baseA	Base emissions
beis3nonox	Eliminated biogenic NOX
cem	Used CEM daily point source data
cmu	Used CMU ammonia inventory
combo1	Combined all sector sensitivities
dust	Cut area dust emissions
s1nonroad	Cut all nonroad by 66%

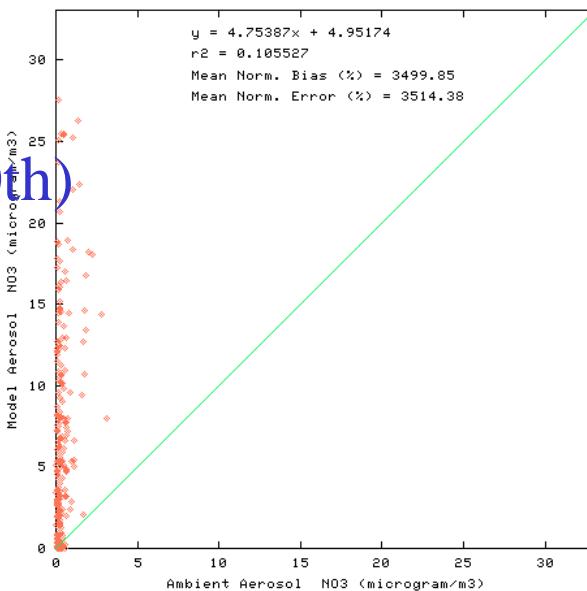
Ambient Aerosol vs. Model Aerosol NO₃ at 34 stations for all days



Ambient Aerosol vs. Model Aerosol NO₃ at 34 stations for all day

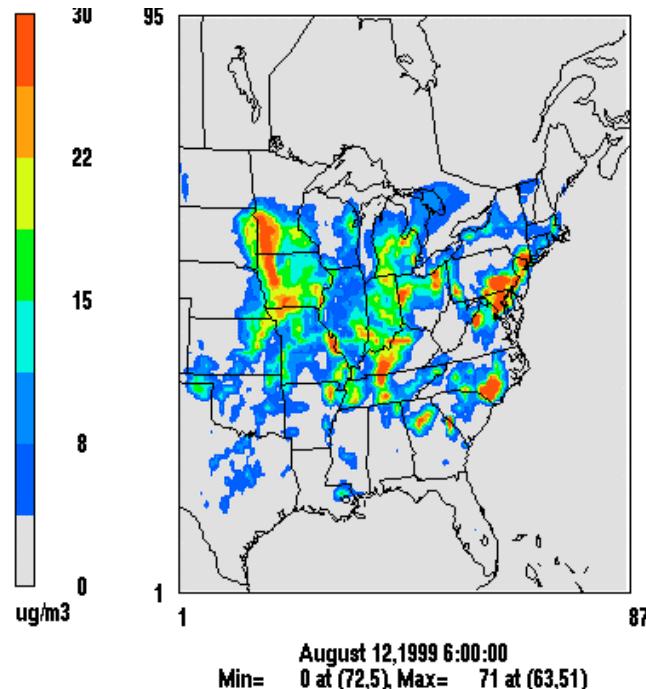


Ambient Aerosol vs. Model Aerosol NO₃ at 34 stations for all days

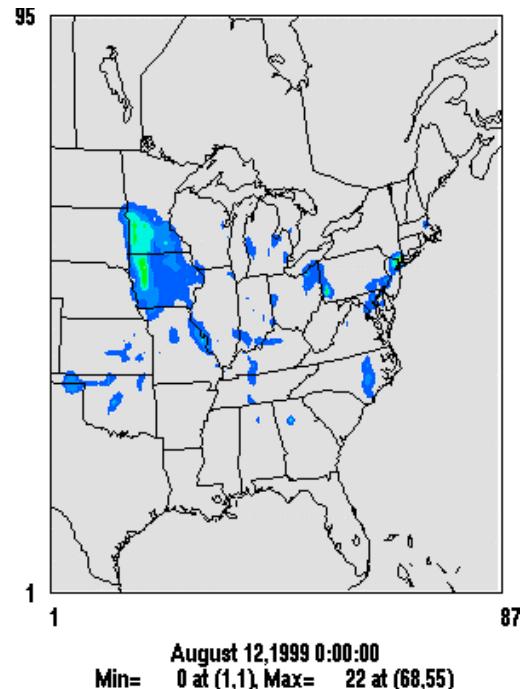


August 1999 (9th to 30th)

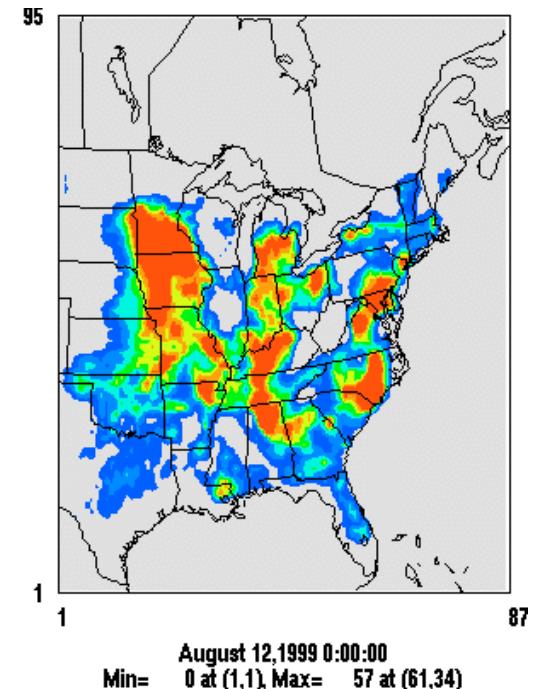
PNO3: CMAQ(june02)

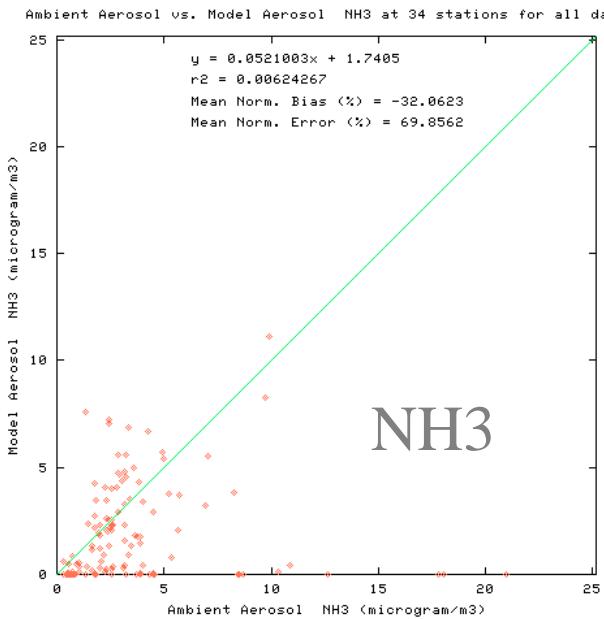


REMSADv7.03

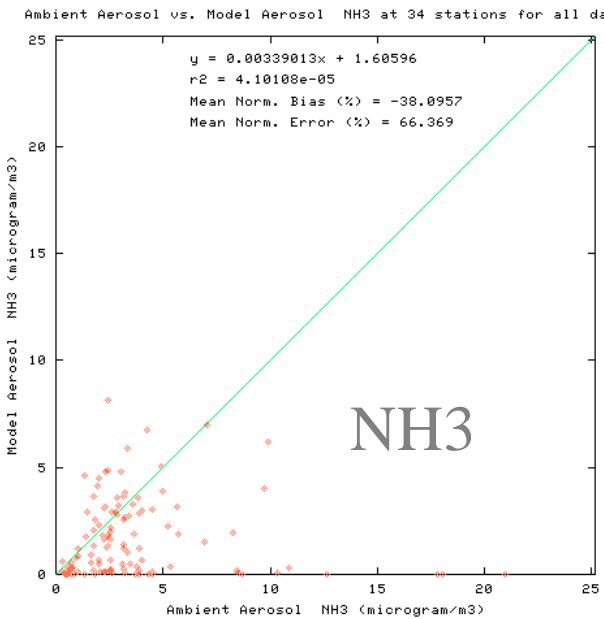


CAMx-M4(beta)

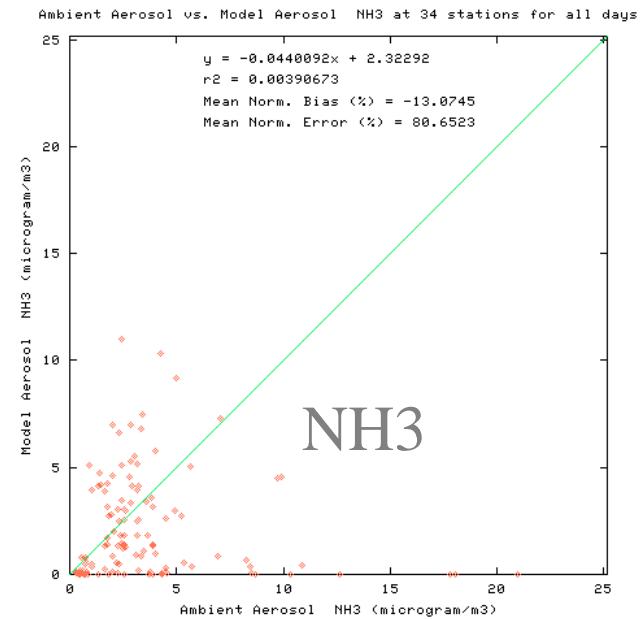




CMAQ(june02)

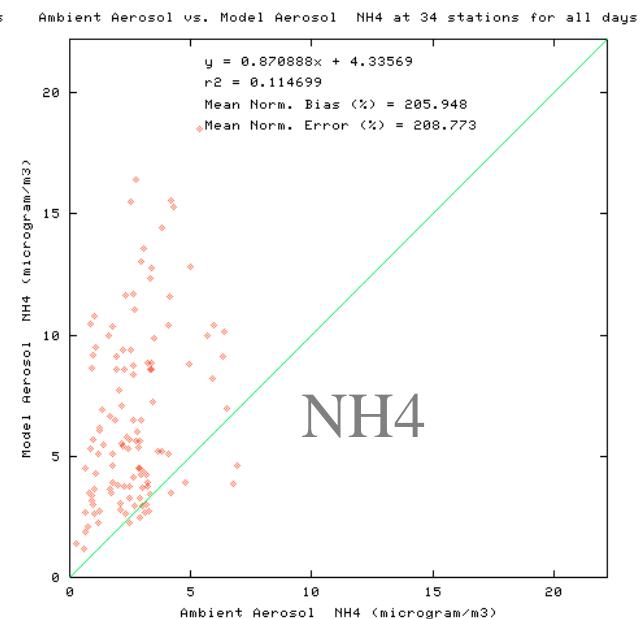
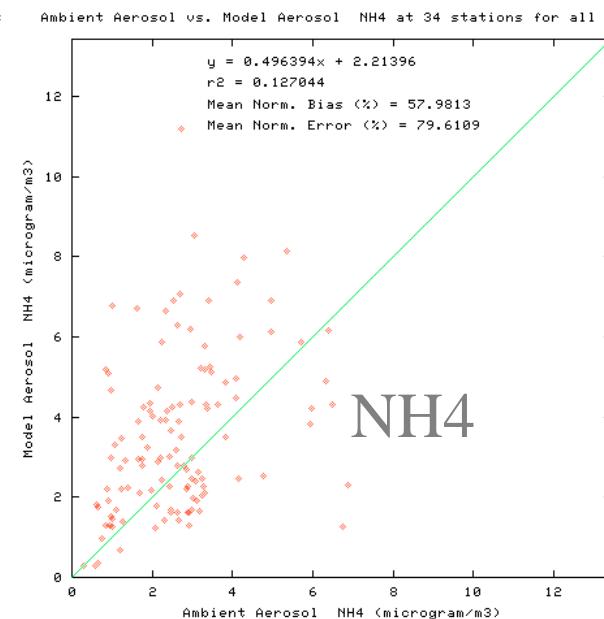
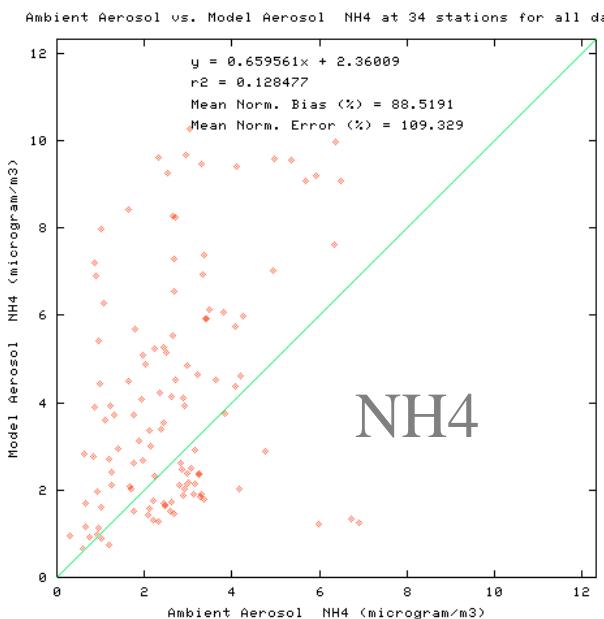


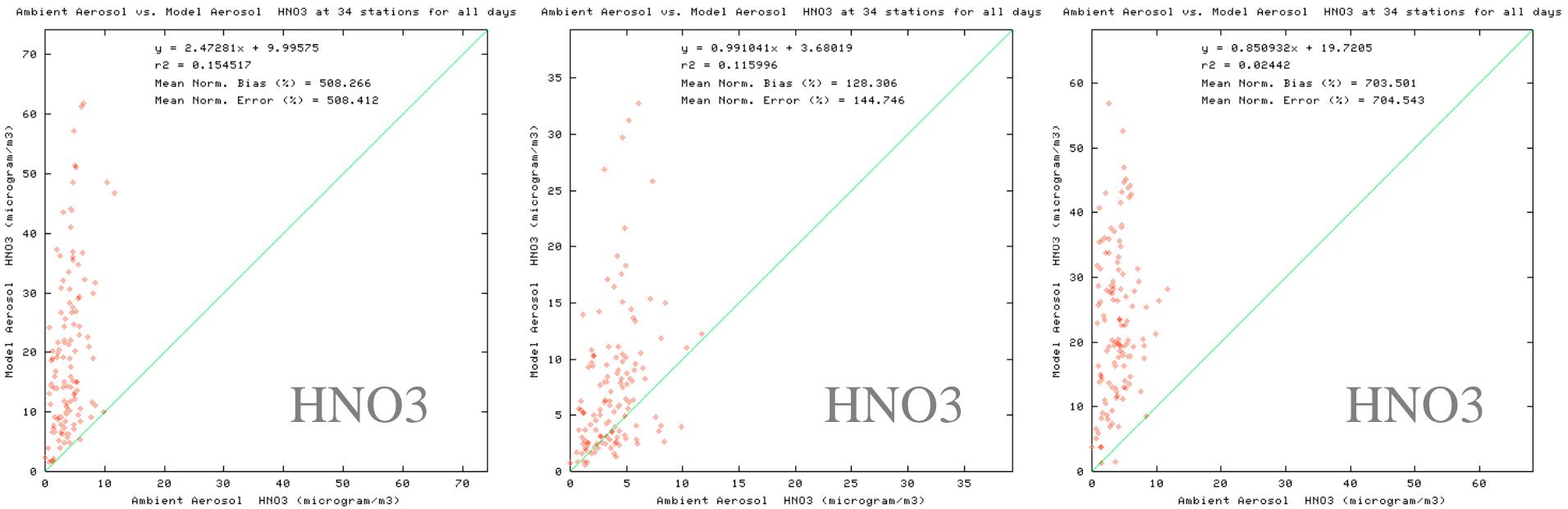
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CAMx-M4(beta)

August 1999 (9th to 30th)



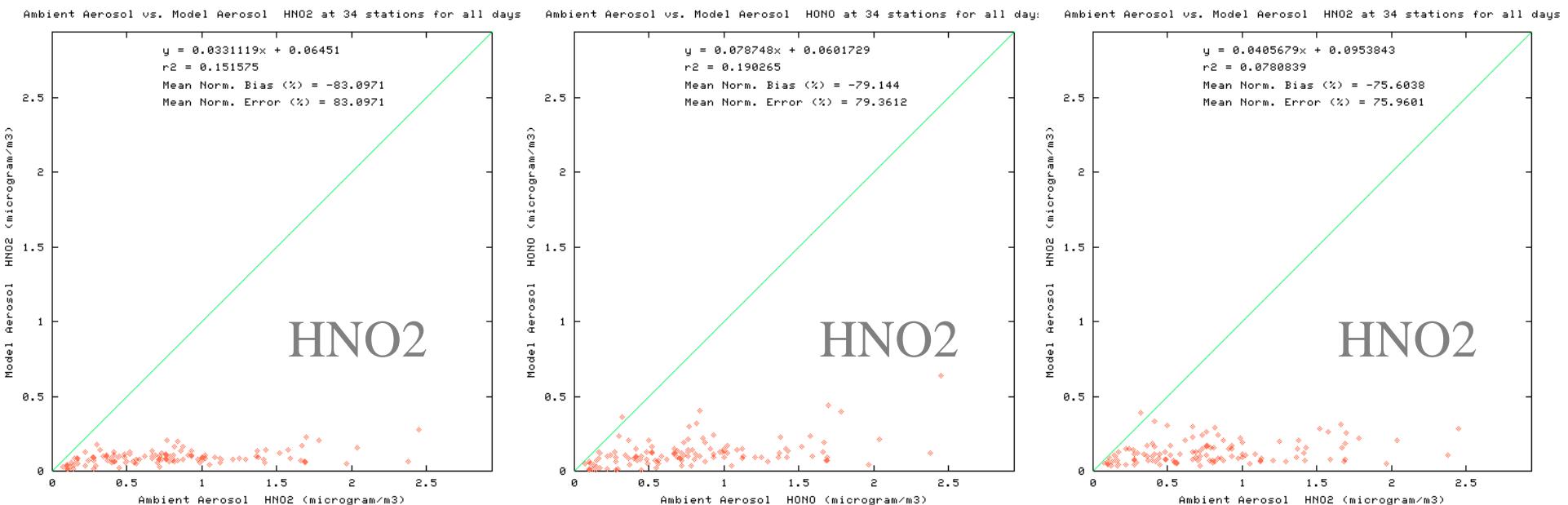


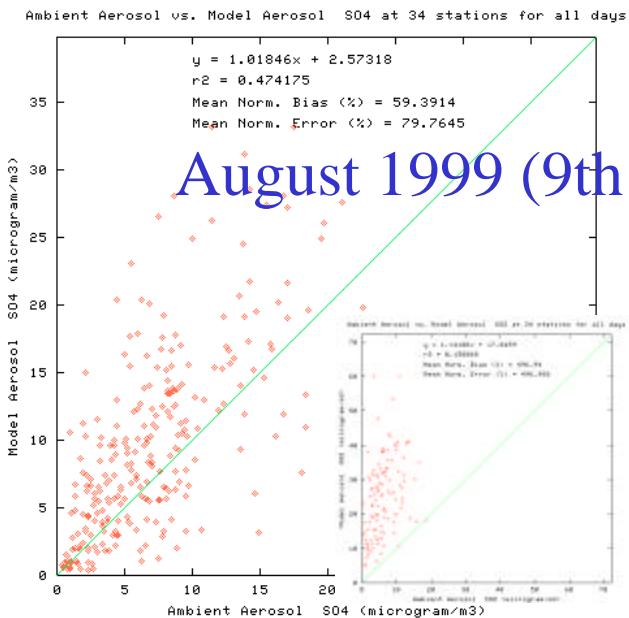
CMAQ(june02)

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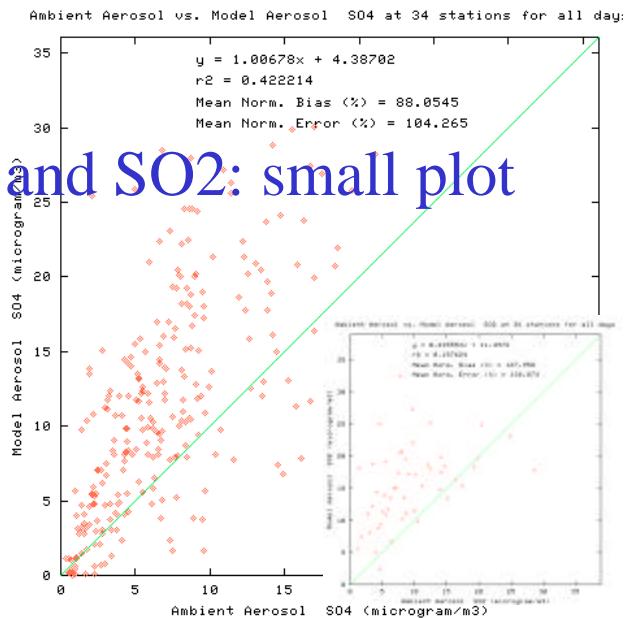
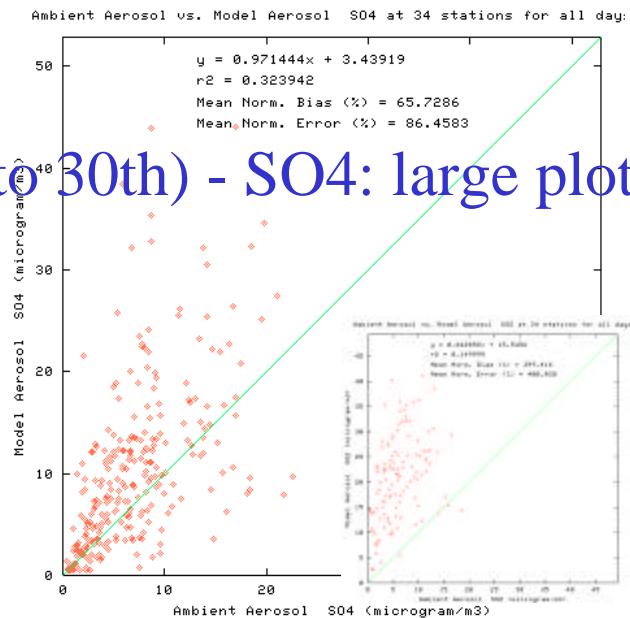
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August 1999 (9th to 30th)

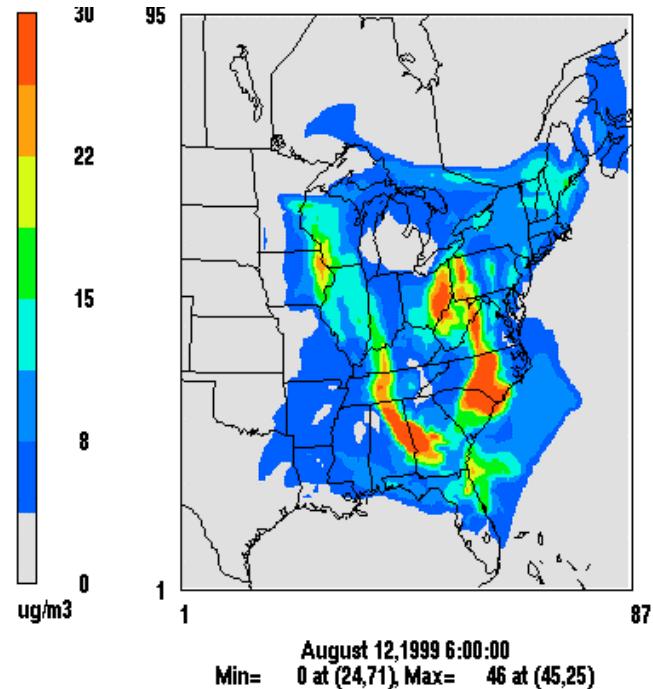




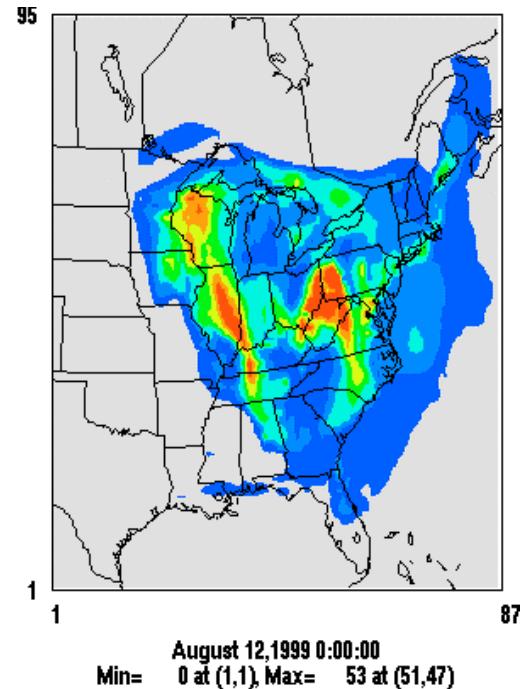
August 1999 (9th to 30th) - SO4: large plot and SO2: small plot



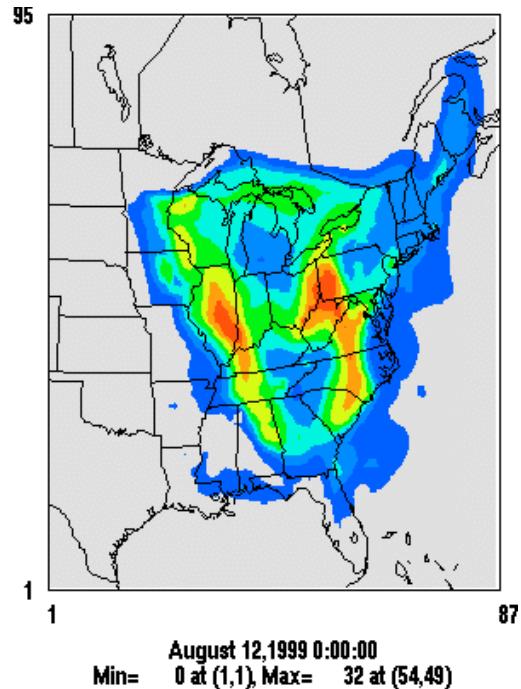
PSO4: CMAQ(june02)

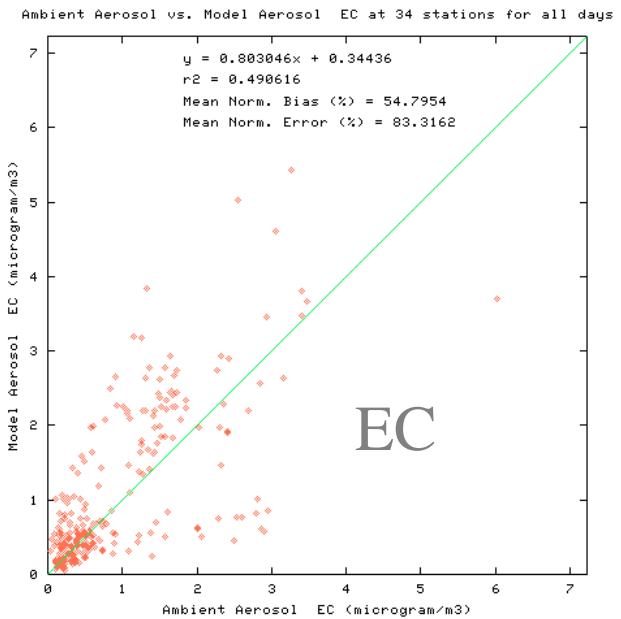


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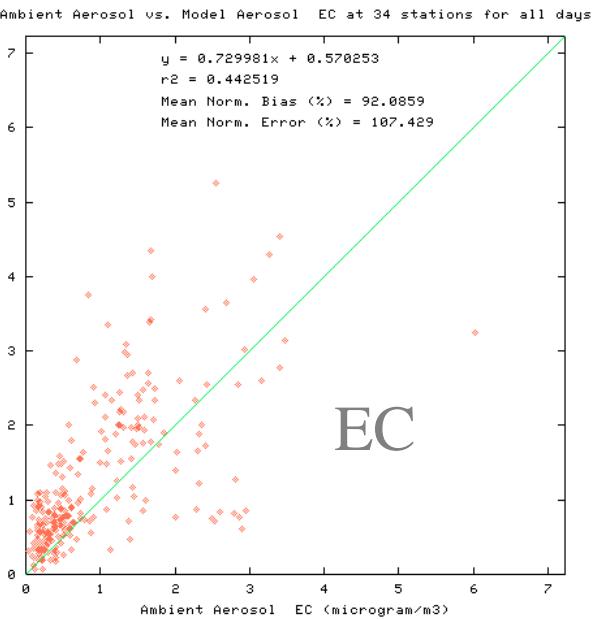


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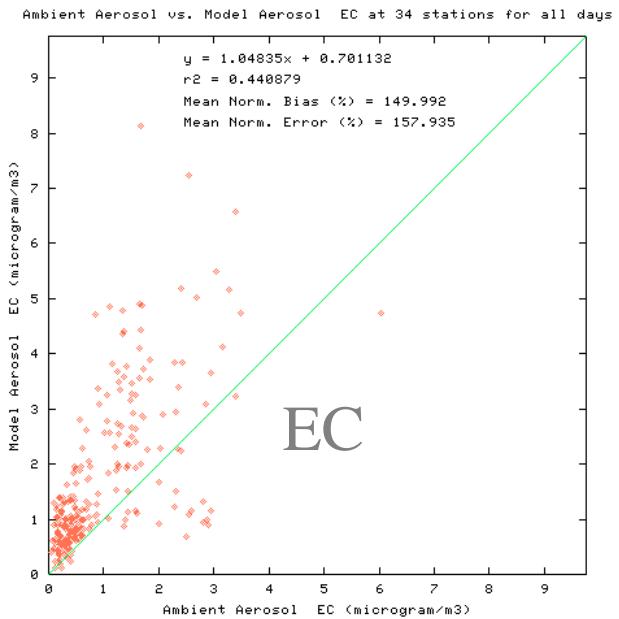




CMAQ(june02)

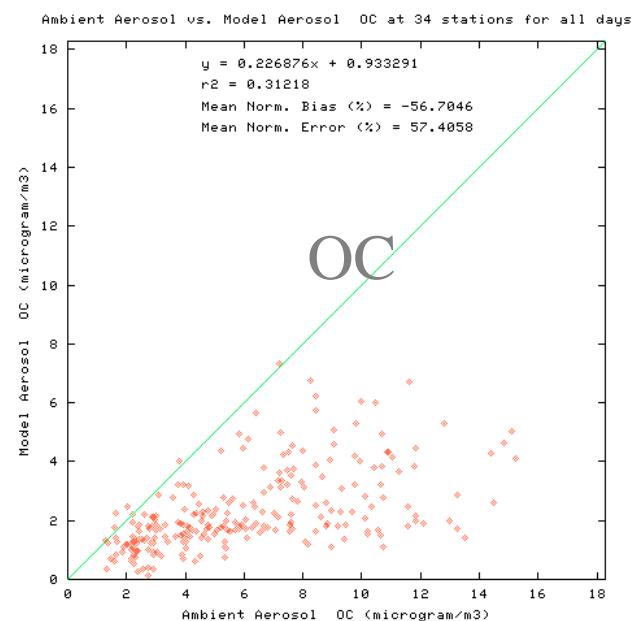
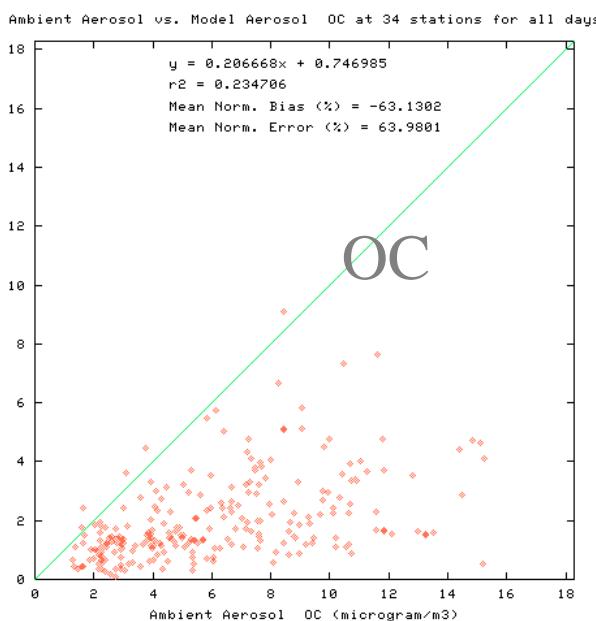
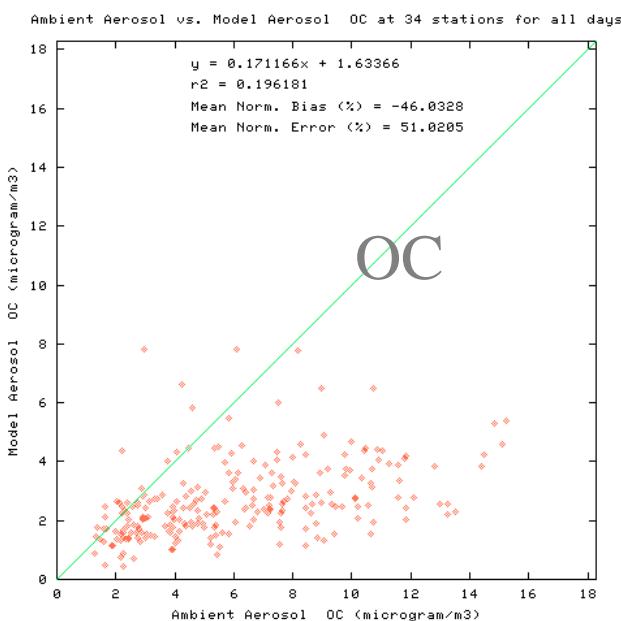


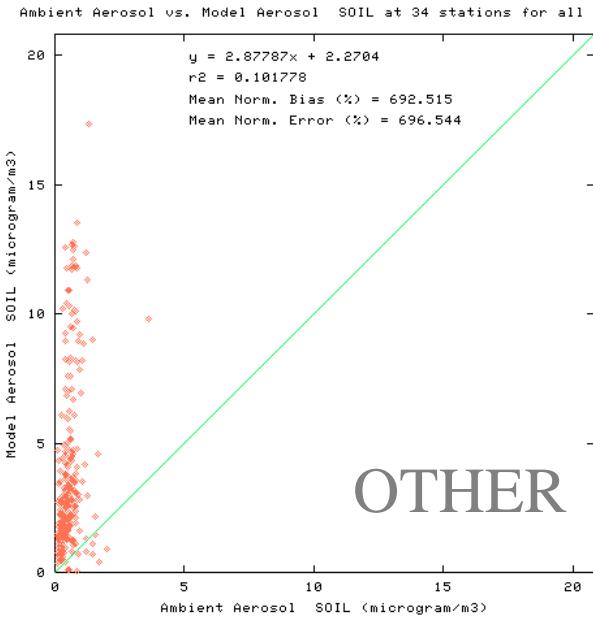
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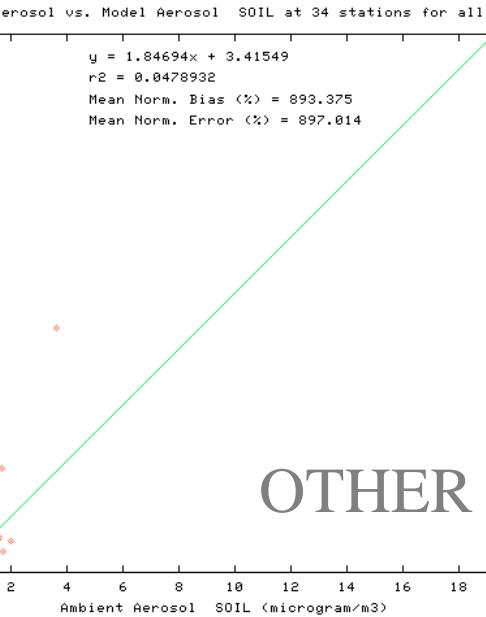
CAMx-M4(beta)

August 1999 (9th to 30th)

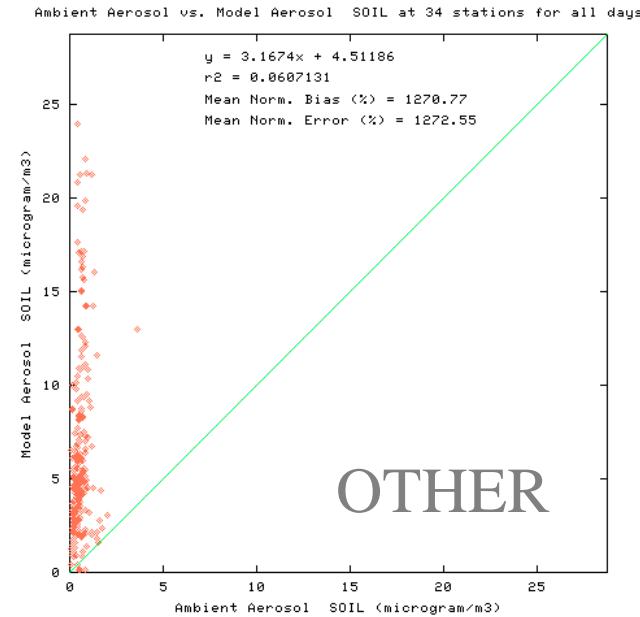




CMAQ(june02)

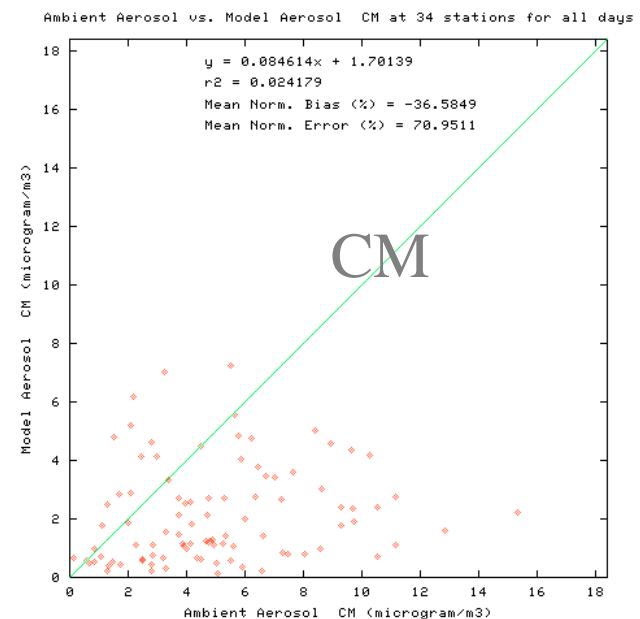
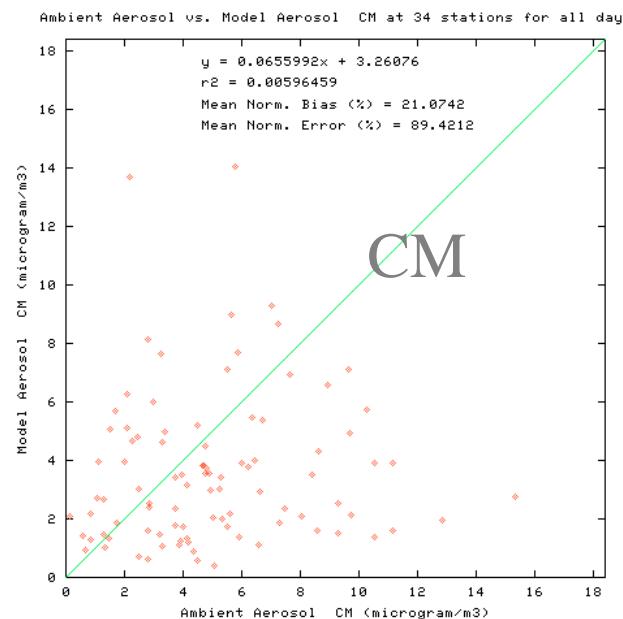
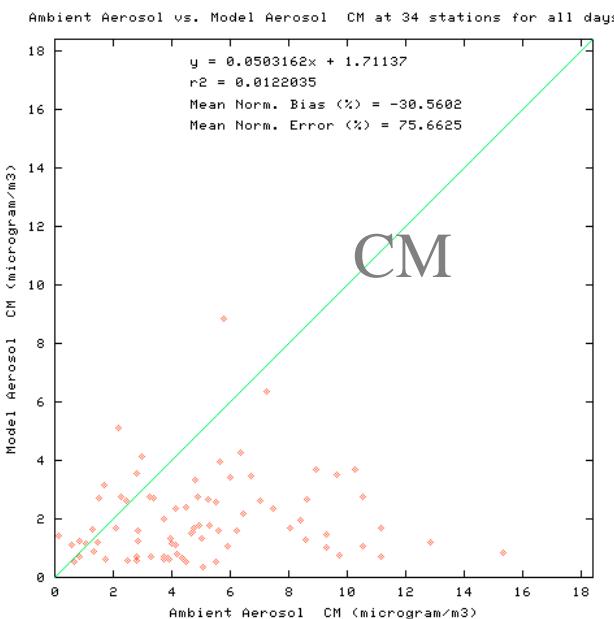


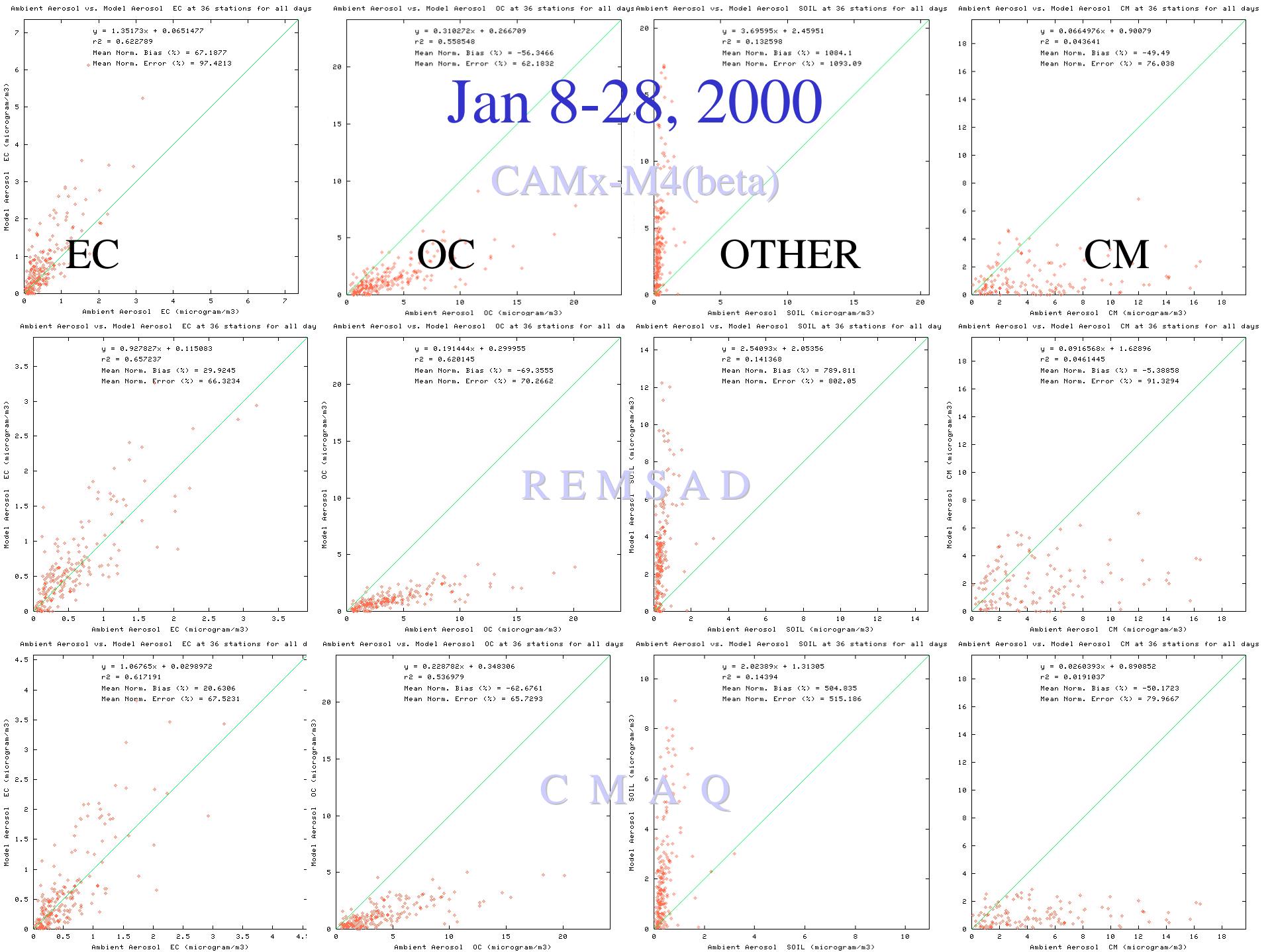
REMSADv7.03



CAMx-M4(beta)

August 1999 (9th to 30th)





Jan 8-28, 2000

CAMx-M4(beta)

OTHER

CM

REMSAD

CMAQ

